Heliophysics Science and the Moon

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NASA MSFC
NASA Lunar Science Conference
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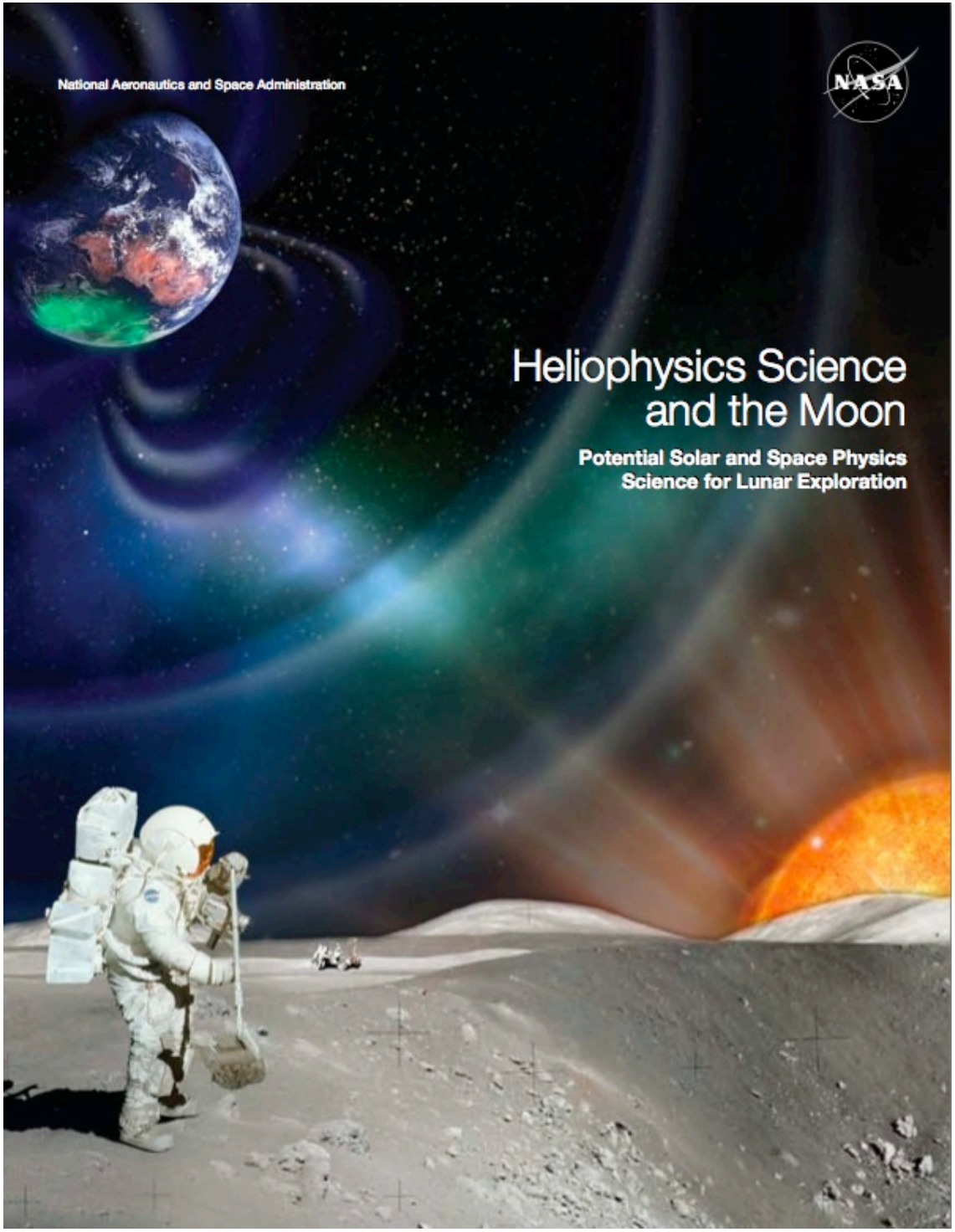
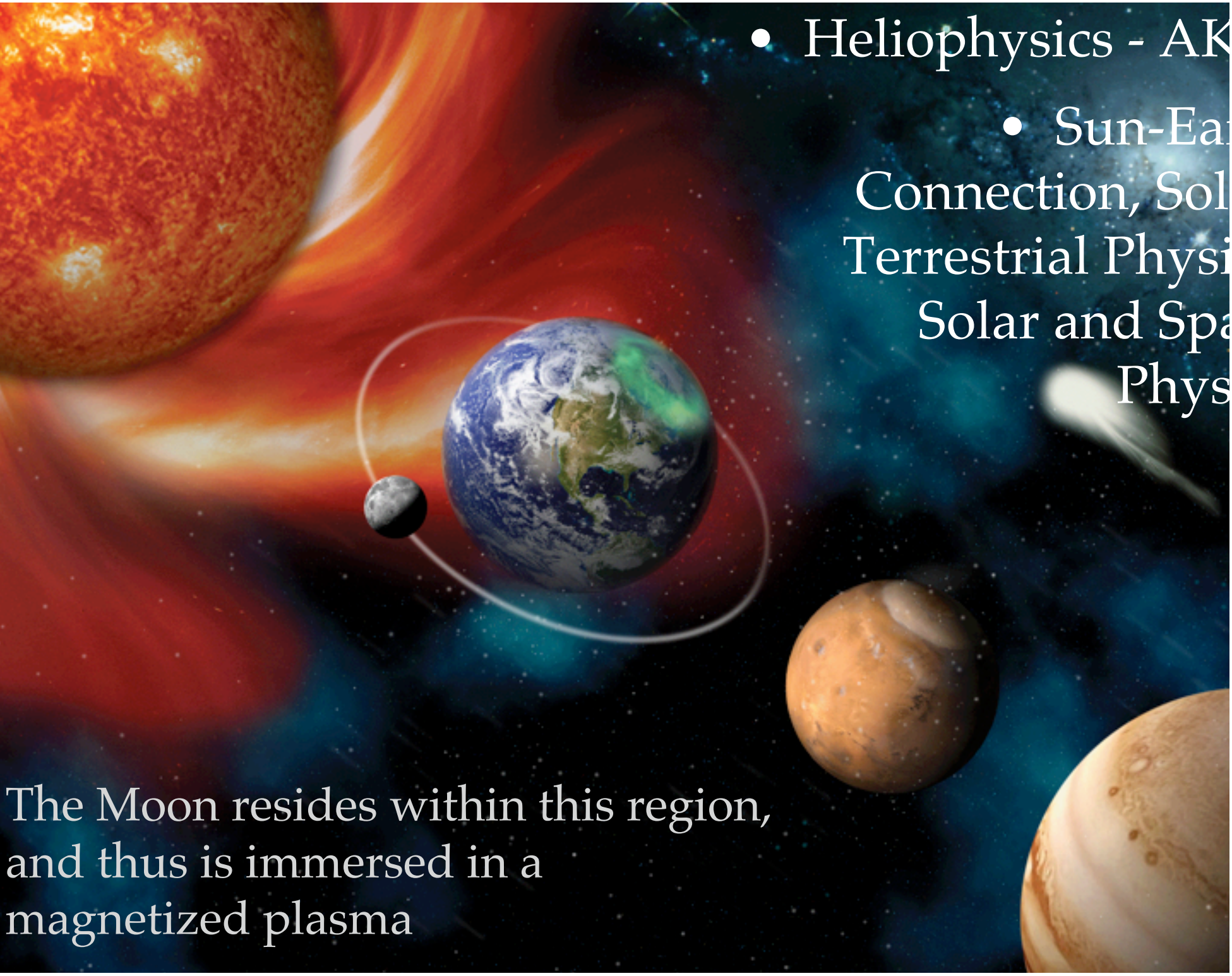


Based on NASA 2007 Heliophysics Science and the Moon report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• Sun-Ea
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Solar and Spa
Phys
The Moon resides within this region,
and thus is immersed in a
magnetized plasma

What is "Heliophysics"?

- The realm of **heliophysics** is the perilous ocean through which explorers, both robotic and human, must journey to reach the dusty shores of the Moon, then Mars.

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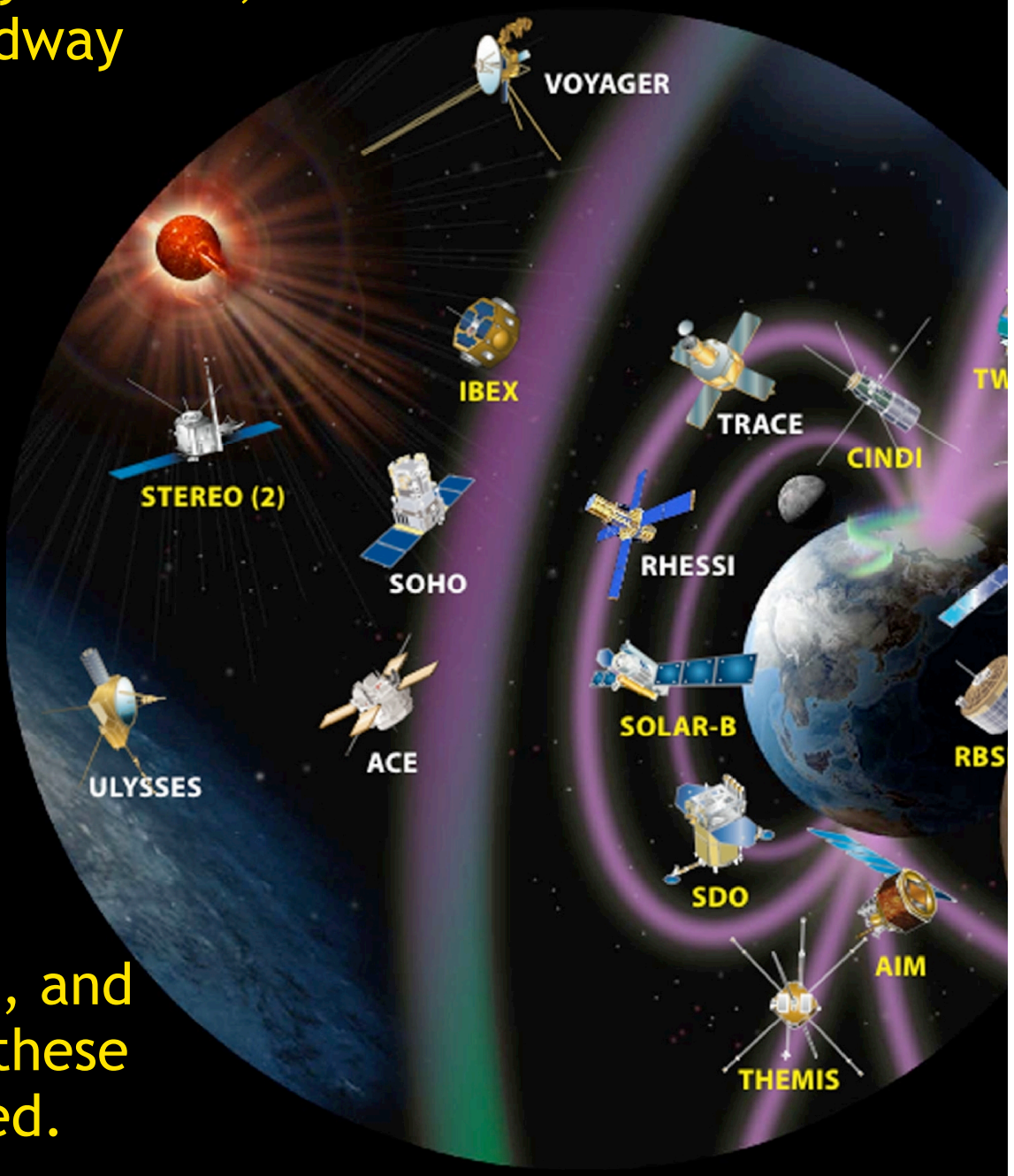
Our Moon is influenced by the Sun, a main-sequence star midway through its stellar life.

Through the eyes of our Heliophysics Great Observatory, we see the Sun, Earth, and Moon as a single, interconnected system moving through interstellar space.

Heliophysics seeks to understand how and why the Sun varies, how the Earth and Moon responds, and how human activities in these environments are affected.



Talk Outline

- Heliophysics Science of the Moon
- Space Weather: Safeguarding the Journey
- The Moon as a Historical Record
- The Moon as a Science Platform

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Heliophysics Science of the Moon

- Plasma and neutral environments
- Magnetotail dynamics at lunar orbit
- Lunar crustal magnetic fields

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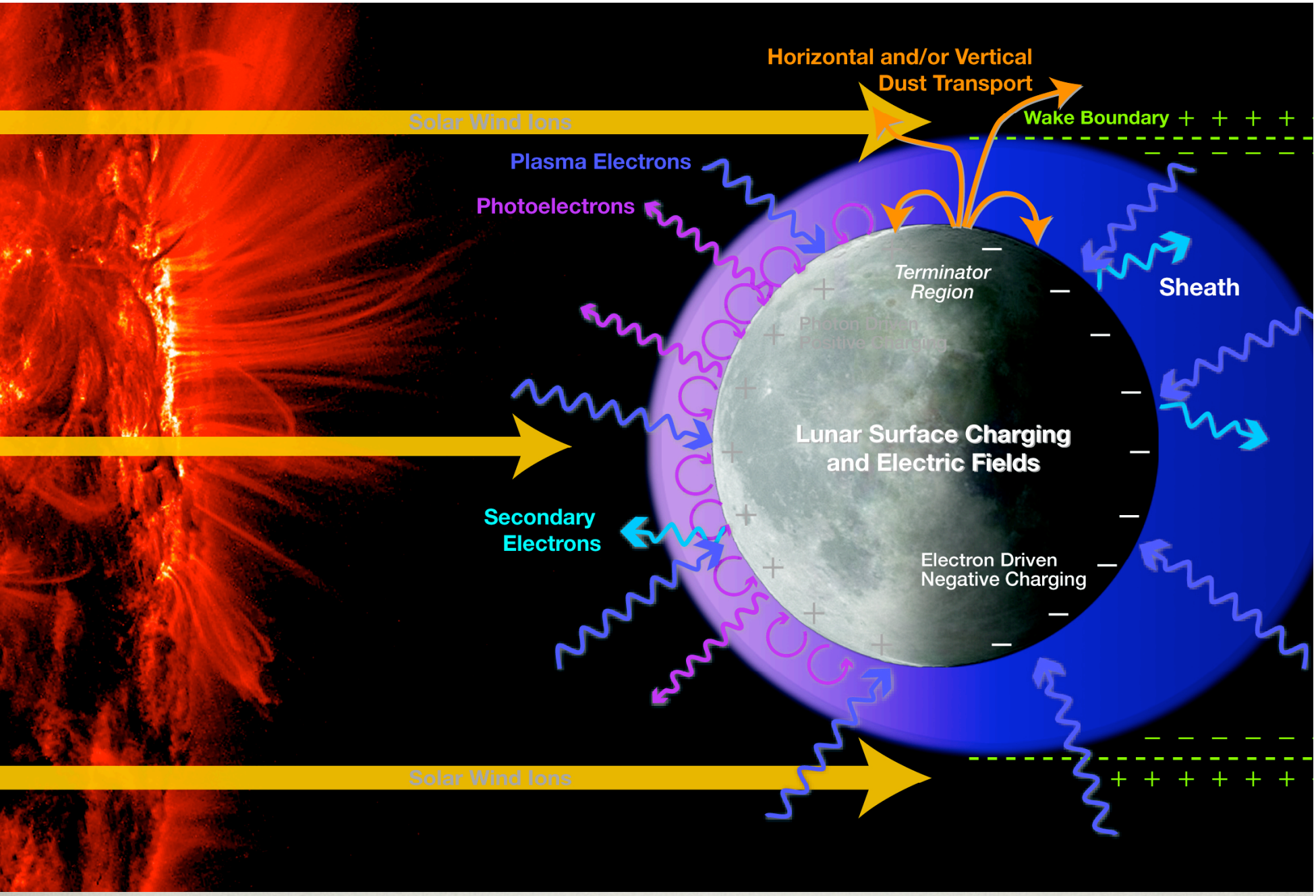

Plasma environment at the Moon

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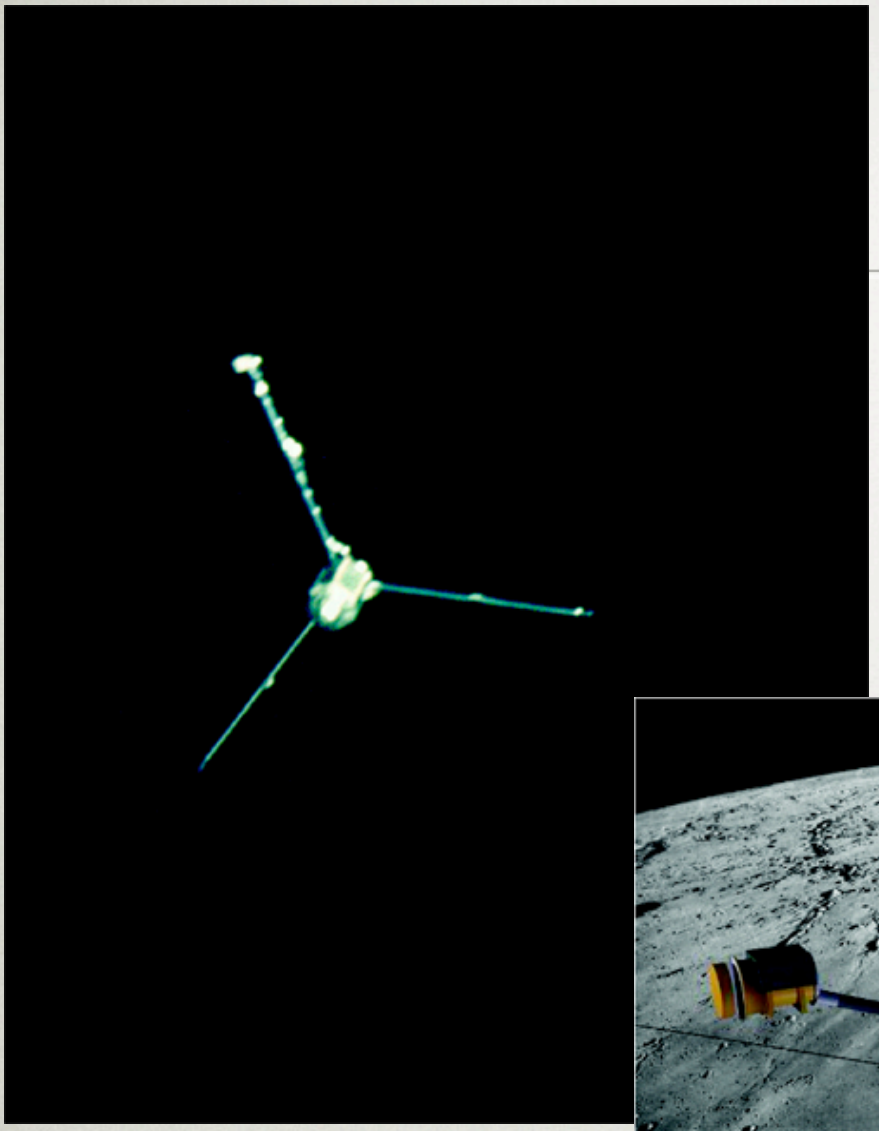

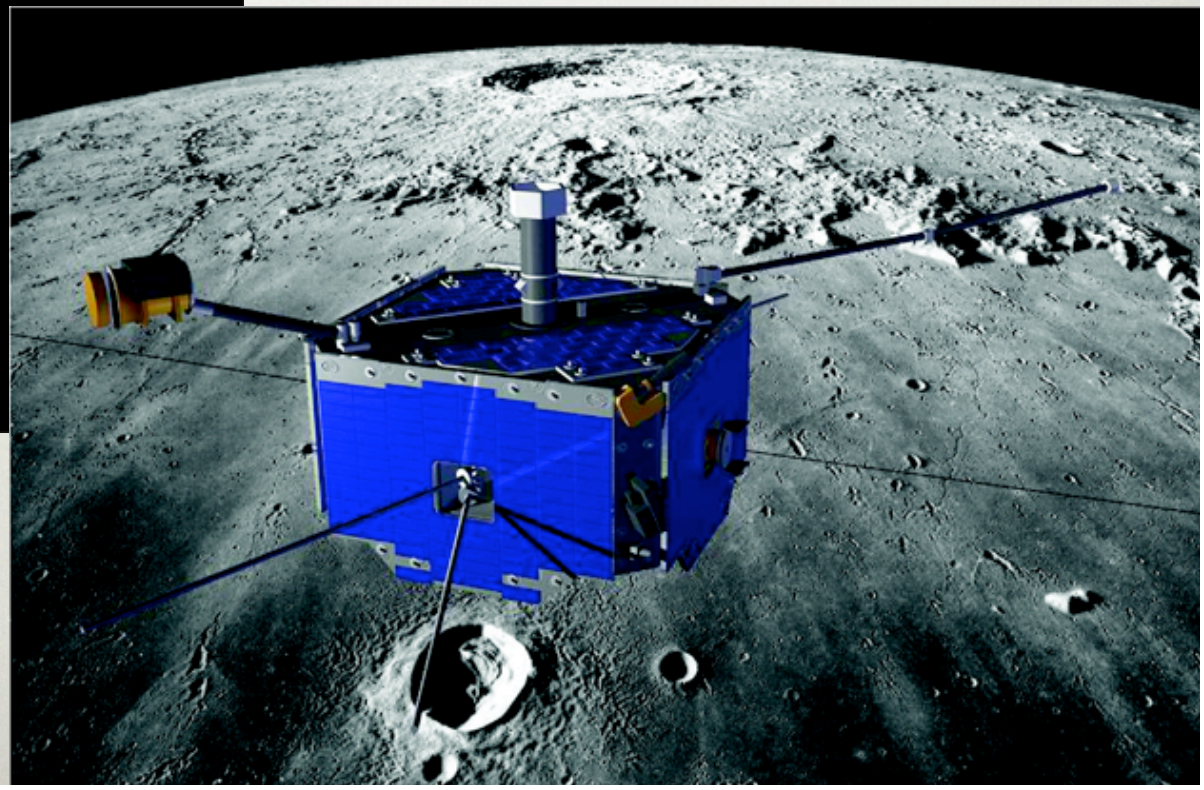

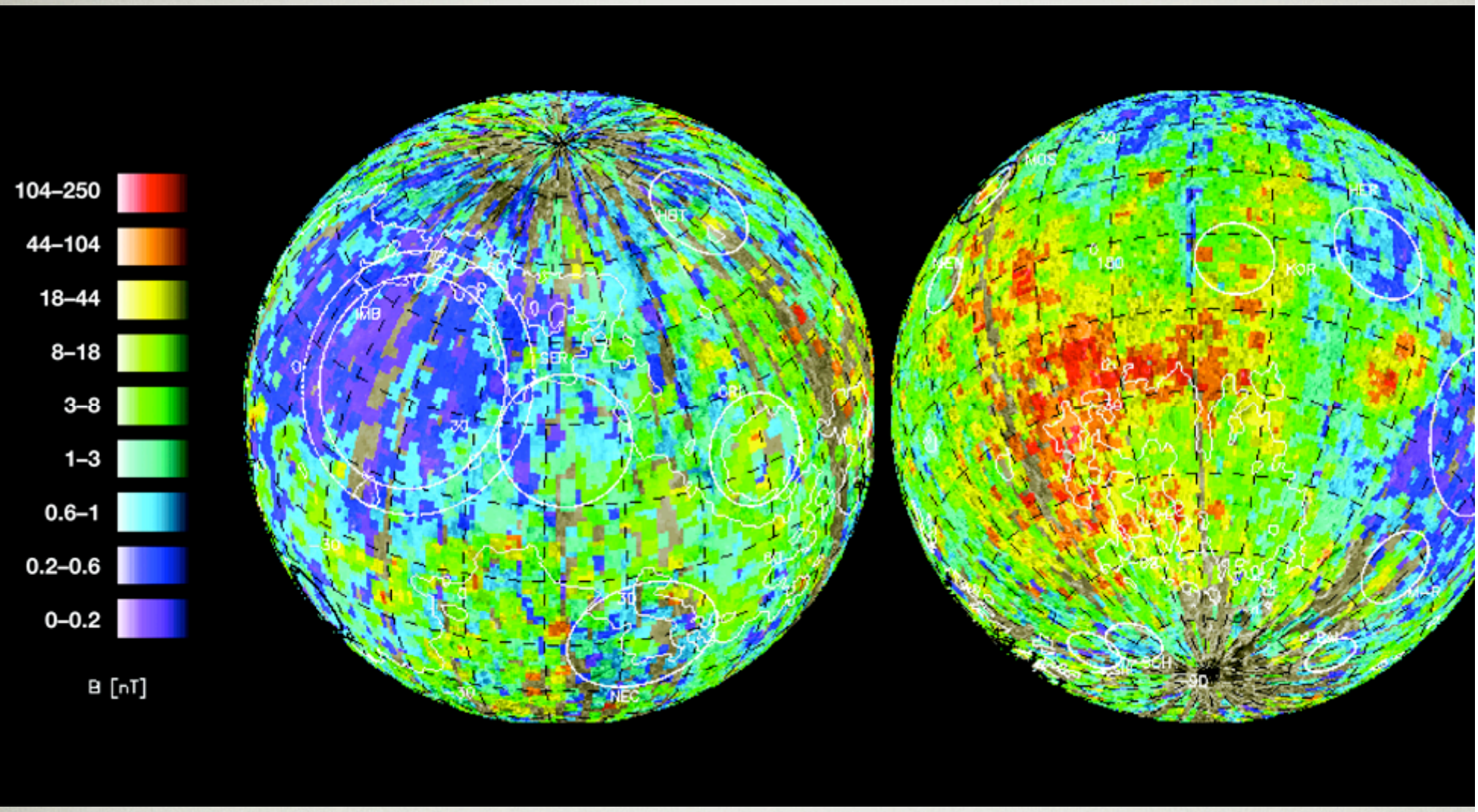

Map of the remanent lunar magnetic field strength measure by electron reflectomet from the Lunar Prospector mission.

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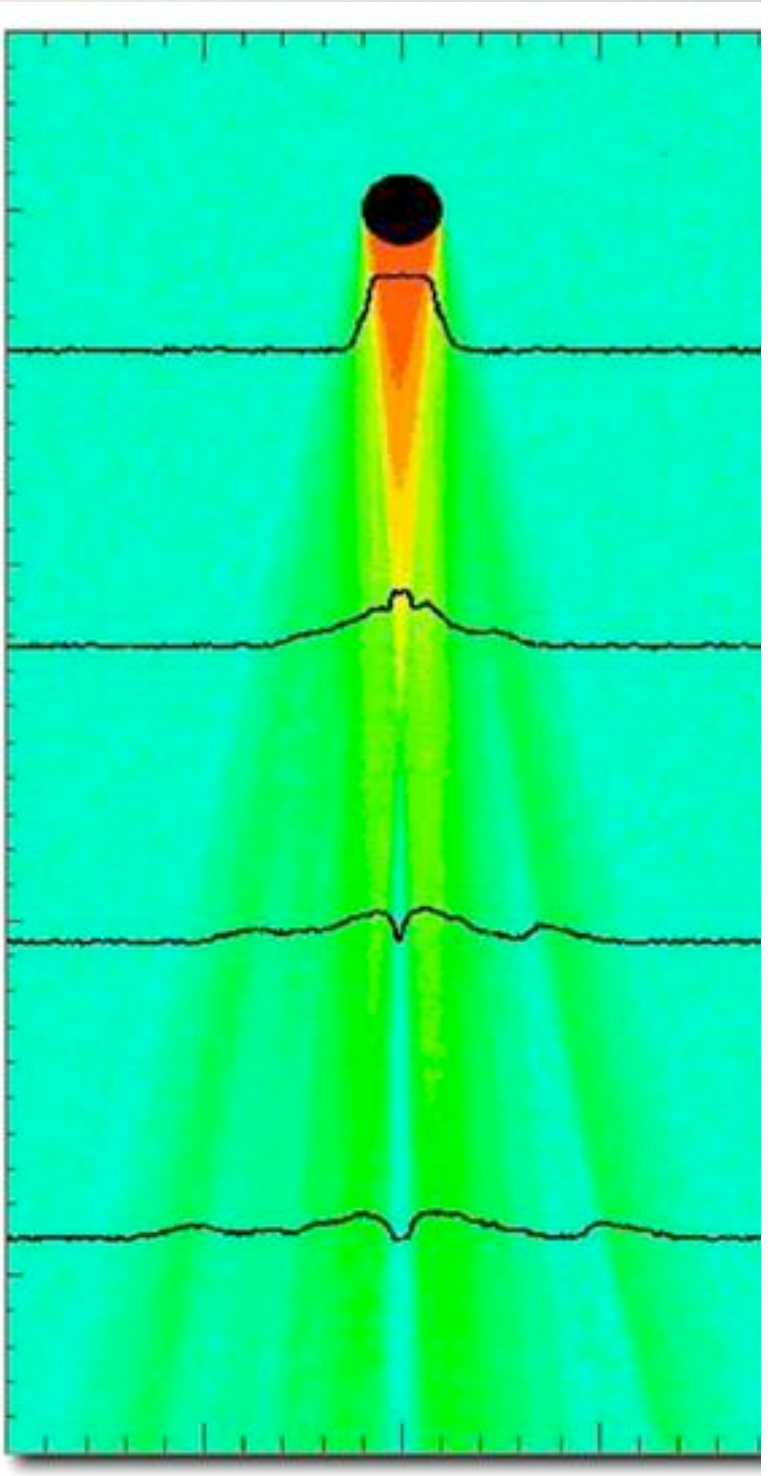
Magnetotail dynamics at lunar orbit



Space Weather: Safeguarding the Journey

- Interaction of dust and plasma on the surface of the Moon and in the exosphere
- Space weather impacts on robotic and human productivity

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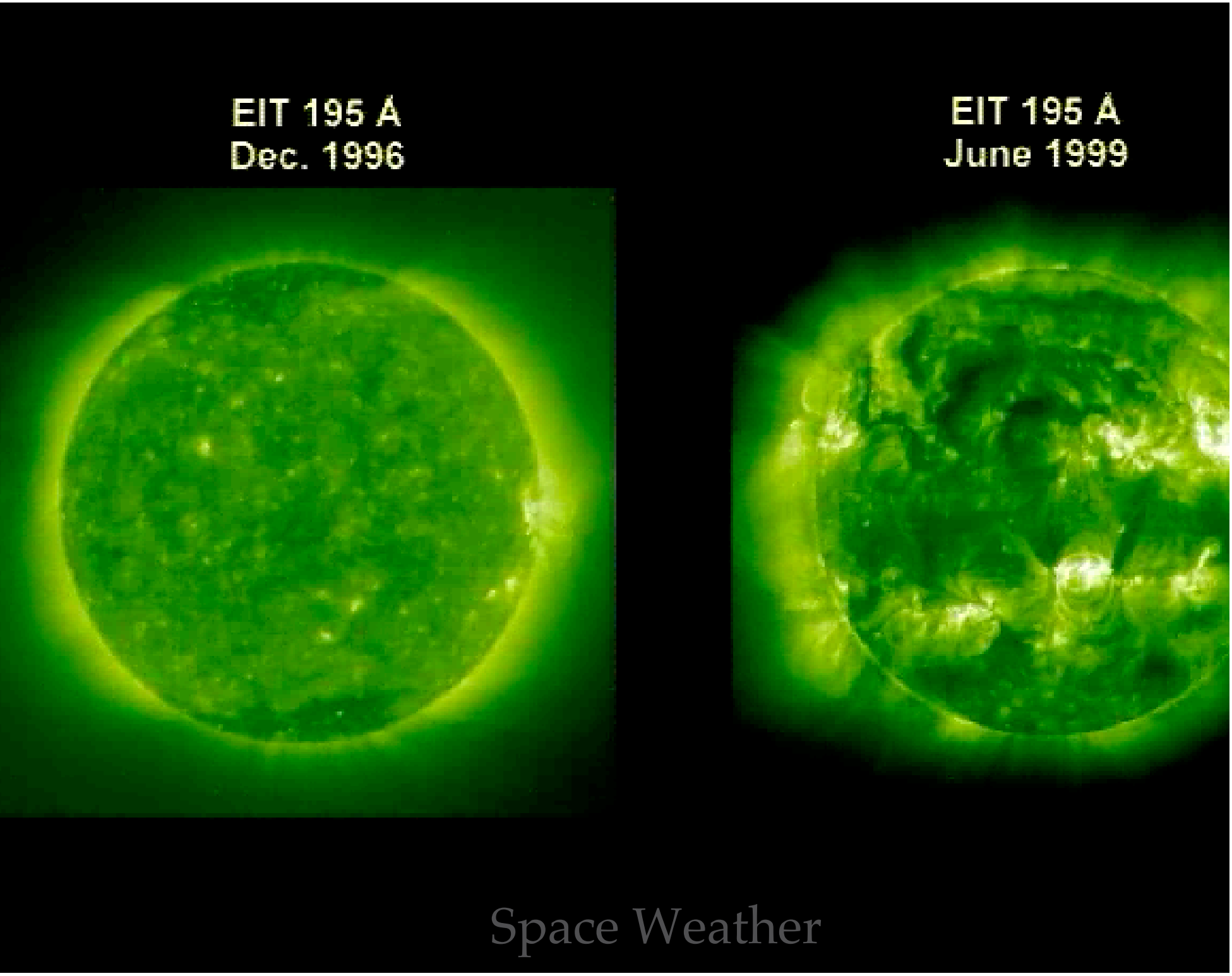
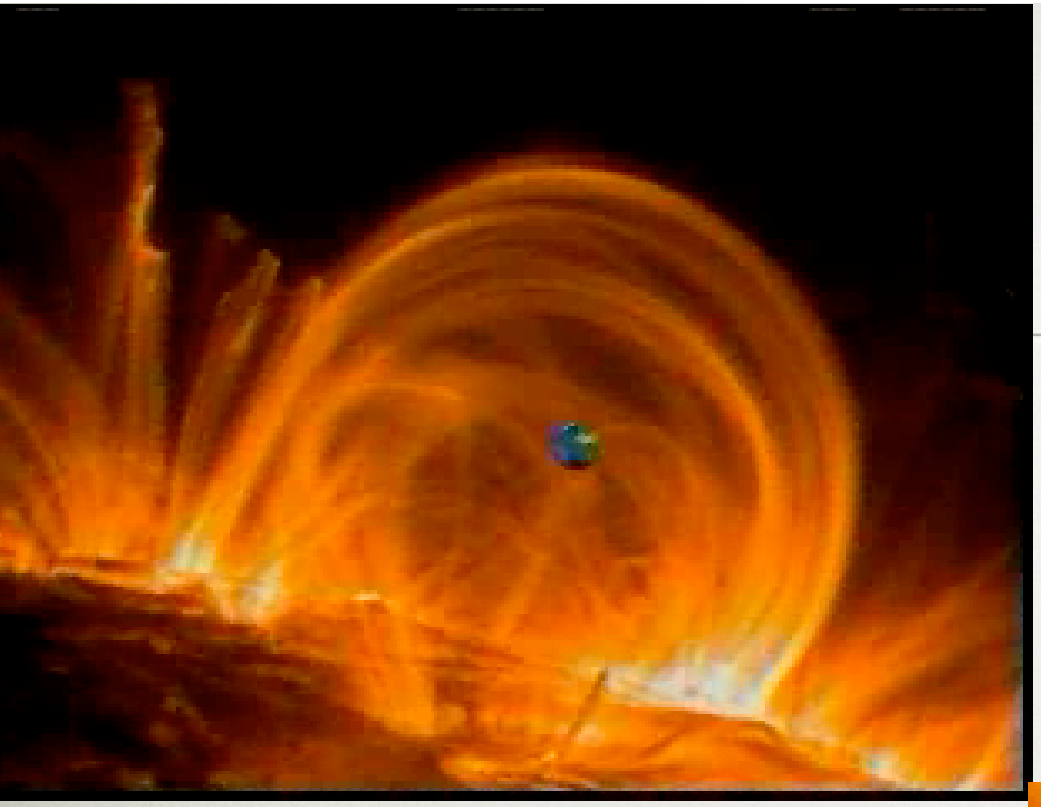
Dust



Space Weather

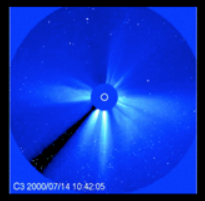


Space Weather

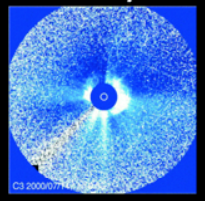
Major Space Environment Hazards

False stars in star tracker CCDs

Before



During exposure to multi-MeV protons



Solar array power decrease due to radiation damage

Before *After*

Surface degradation from radiation

Single event effects in microelectronics

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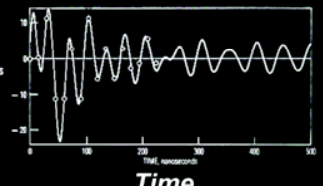
Electronics degrade due to total radiation dose

Solar array arc discharge

Spacecraft components become radioactive

Electromagnetic pulse from vehicle discharge (on surface, behind thin shielding, or deep inside)

Induced Voltage



Time

The Moon as a Historical Record

- History of the Sun, cosmic radiation, and local interstellar medium
- Composition of the solar wind
- History of the Inner Solar System According to Lunar Cold Traps

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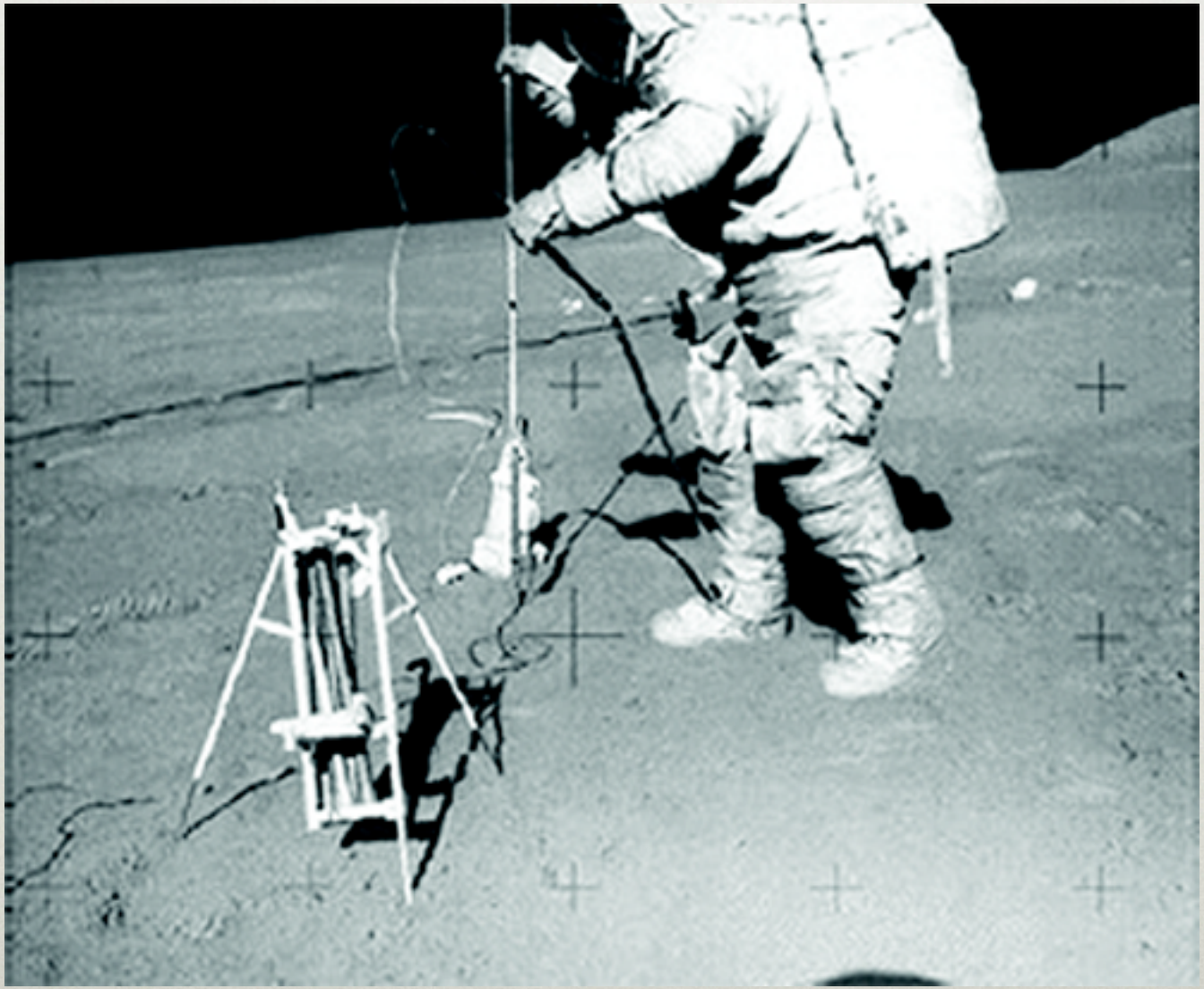
History of the Sun



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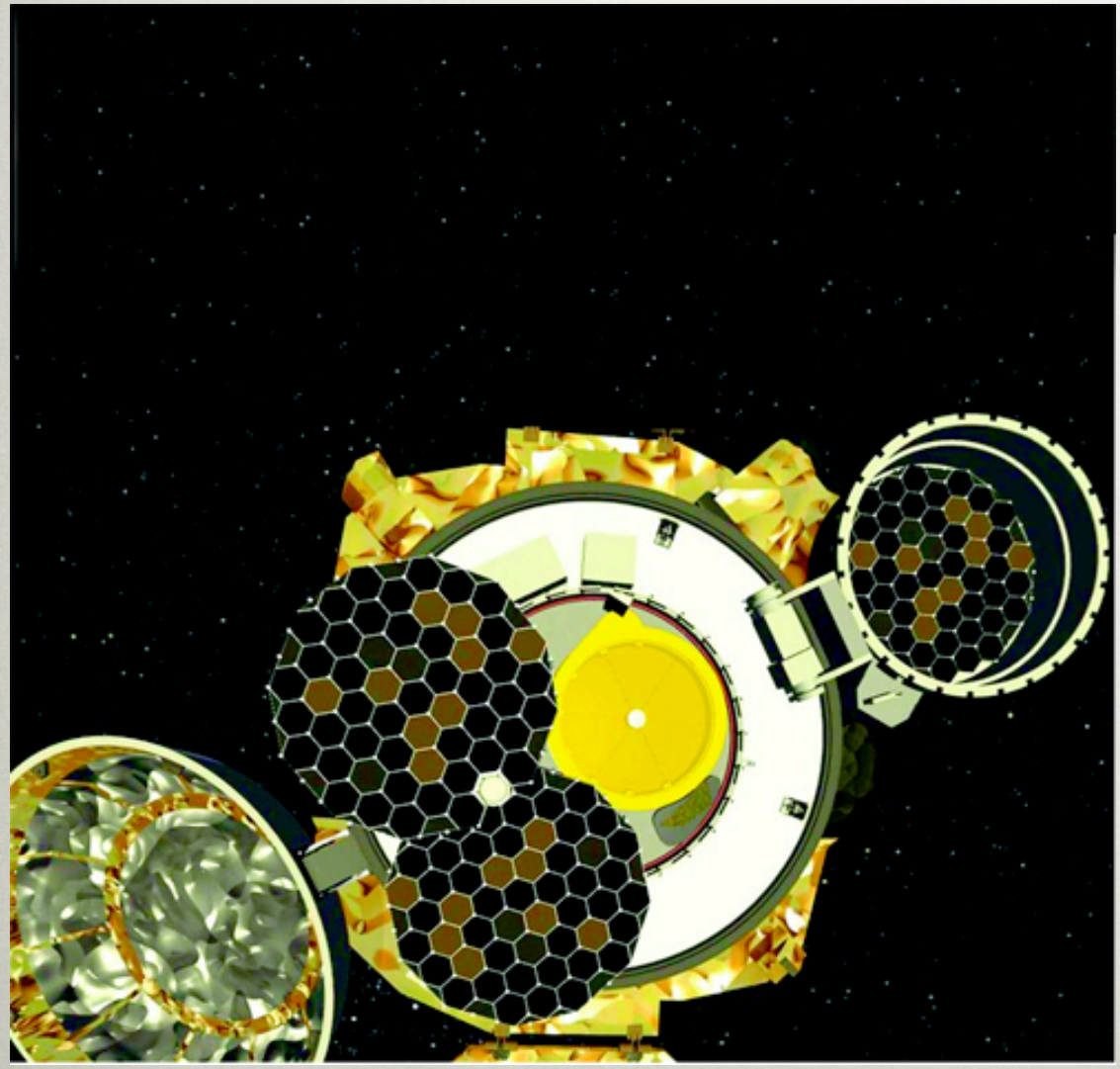
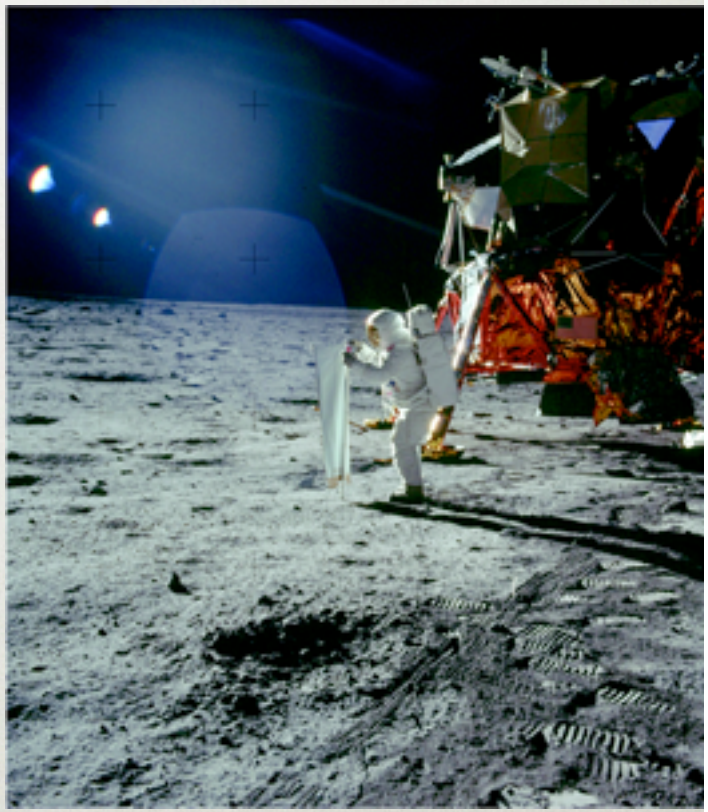
Composition of the Solar Wind





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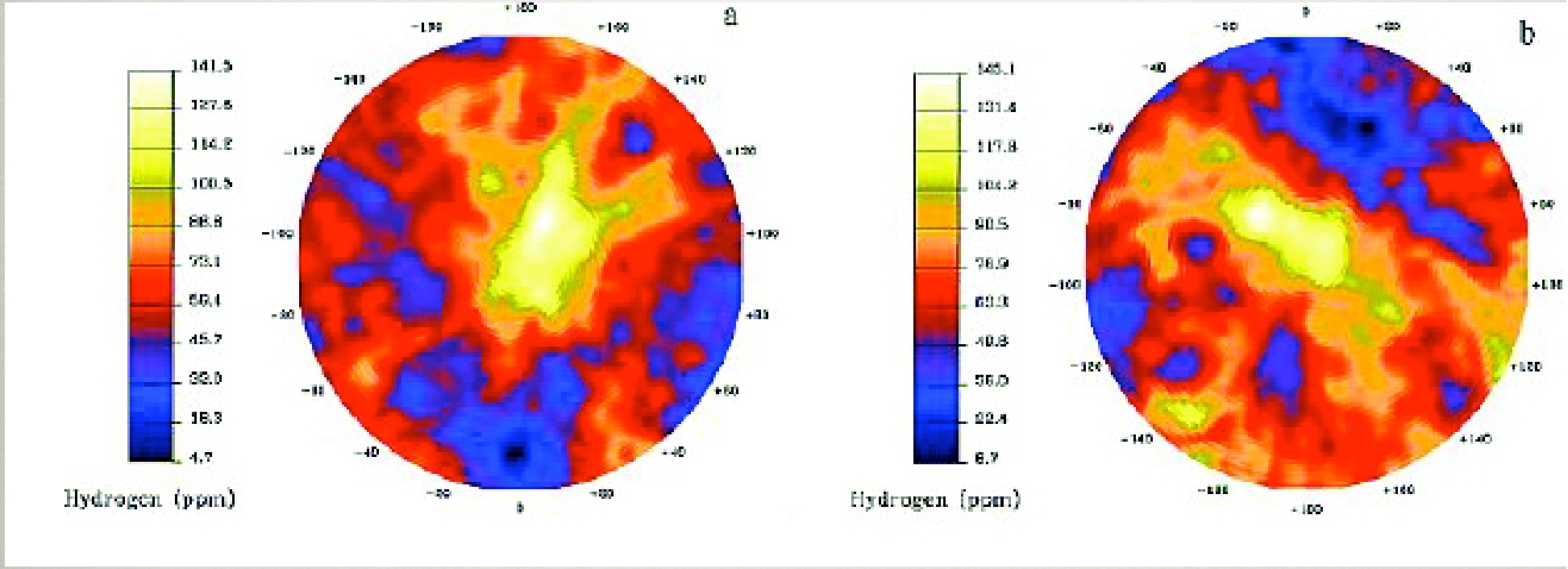
History of the Local Inner Solar System



Hydrogen distribution at the lunar polar regions

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The Moon as a Science Platform

- Imaging of the Heliospheric Boundary
- Low-frequency radio observations
- Sun's Role in Climate Change
- Ionosphere/Magnetosphere Imaging
- High-Energy Solar Observatory and an Optical Solar Observatory

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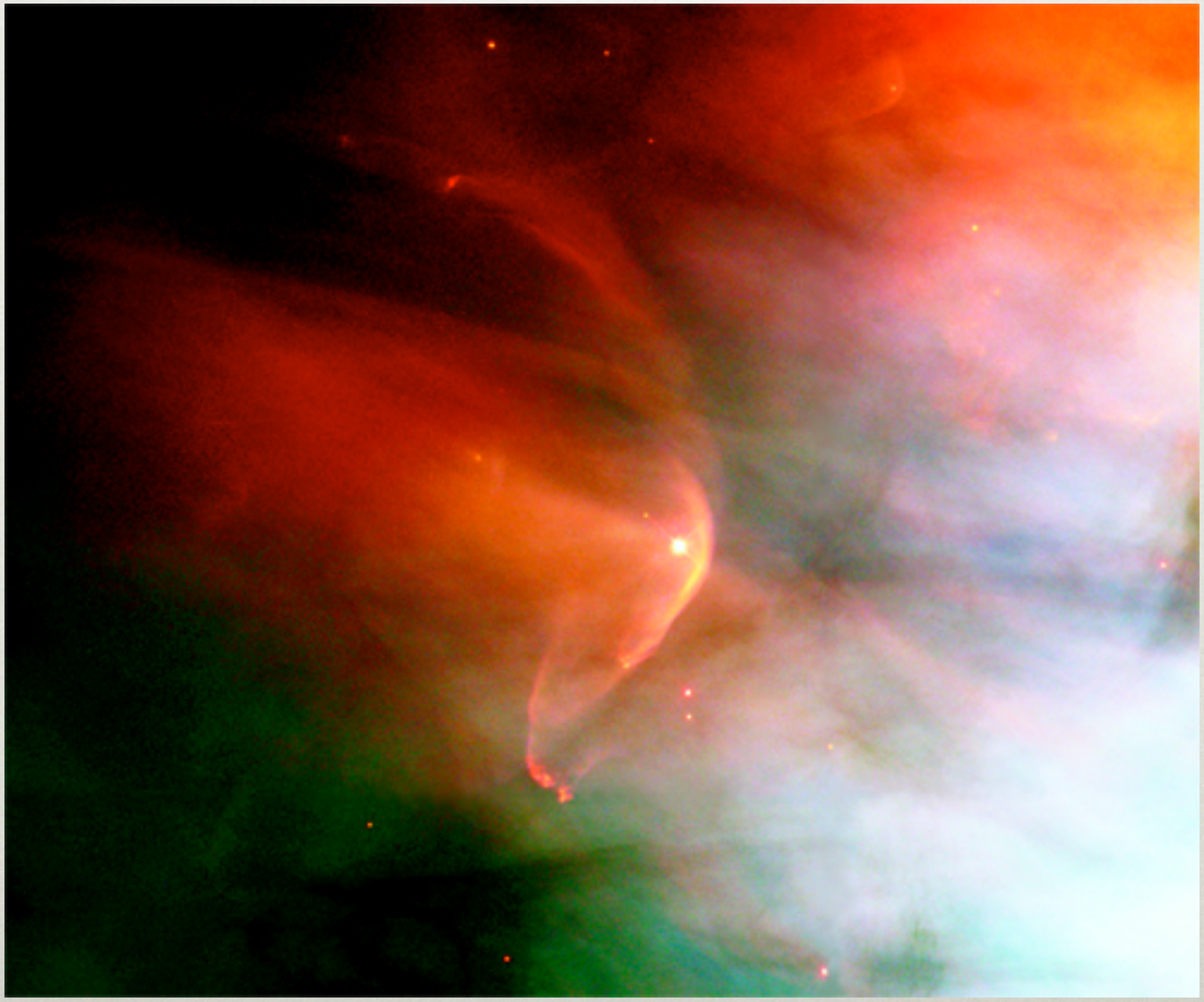
Imaging of the Heliospheric Boundary



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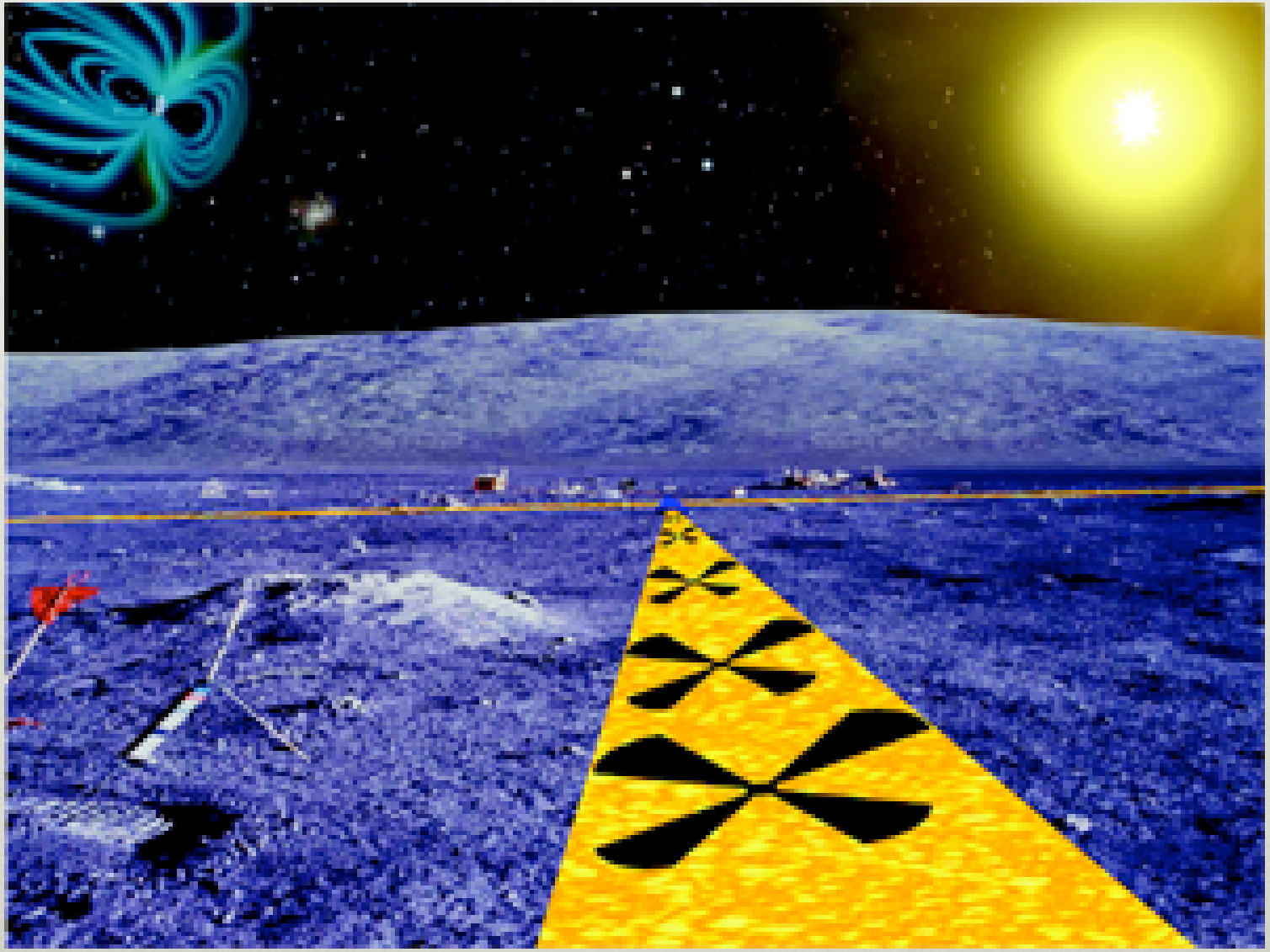
Low-frequency radio observations of the Sun



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Sun's Role in Climate Change

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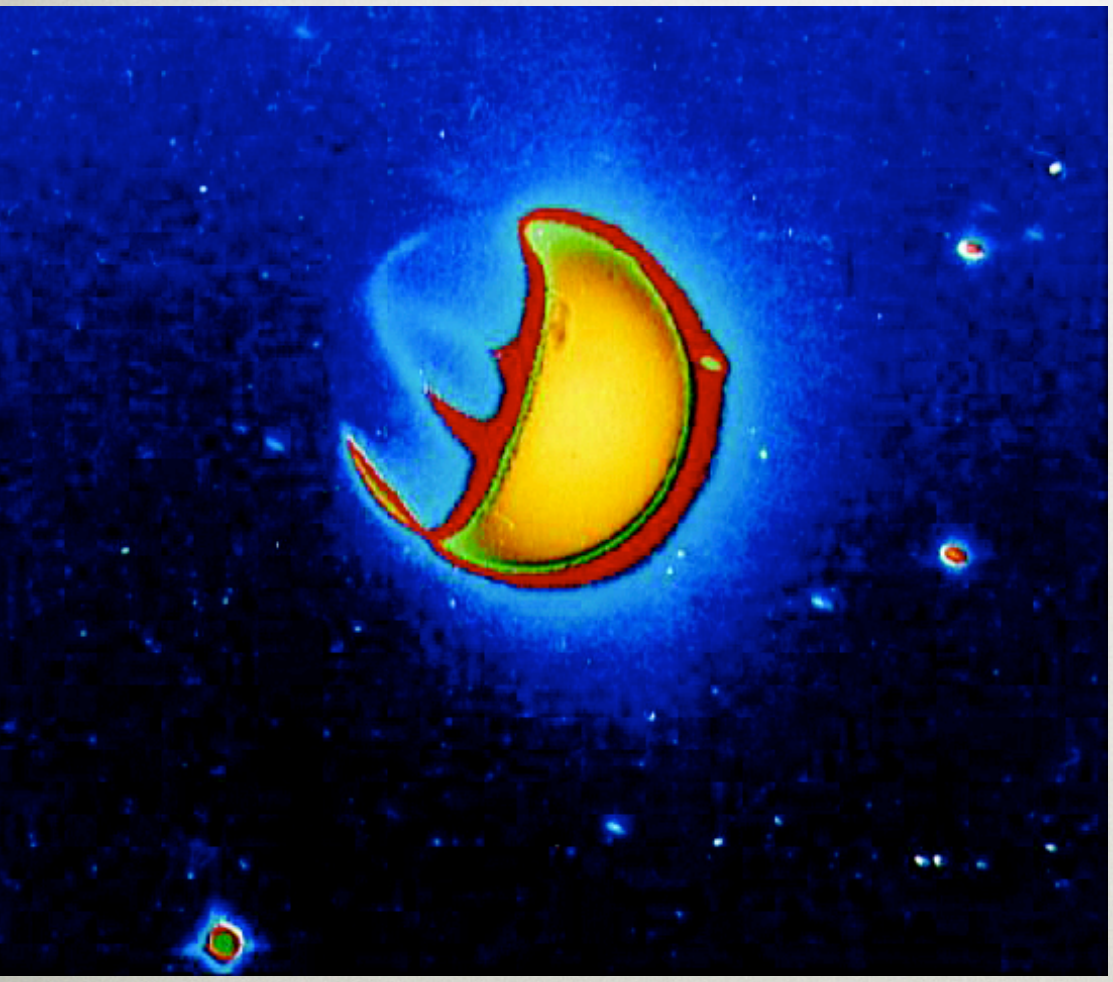
Ionosphere and Magnetosphere Imaging



Apollo 1

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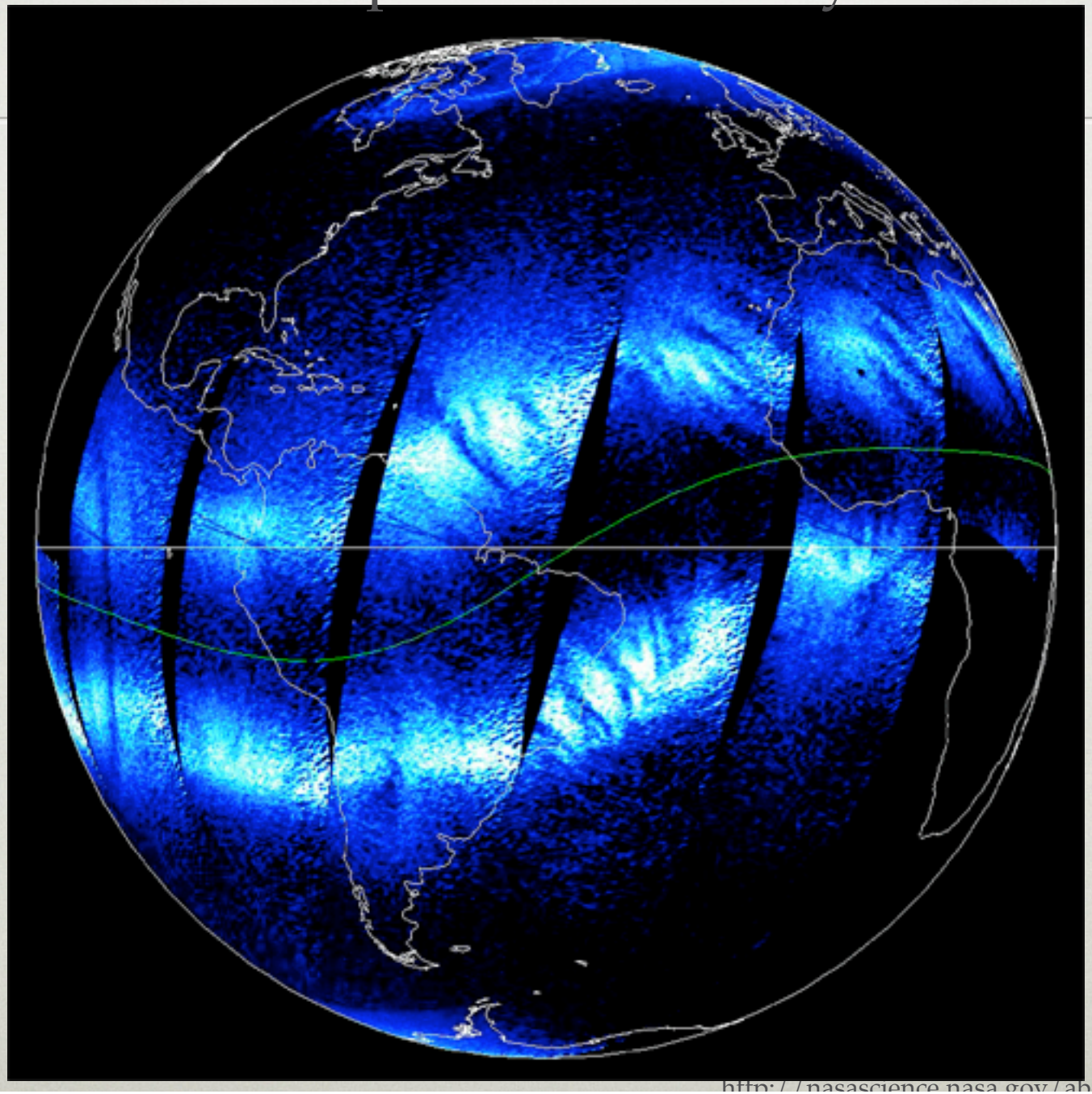
Composite image of equatorial emissions showing ionospheric variability



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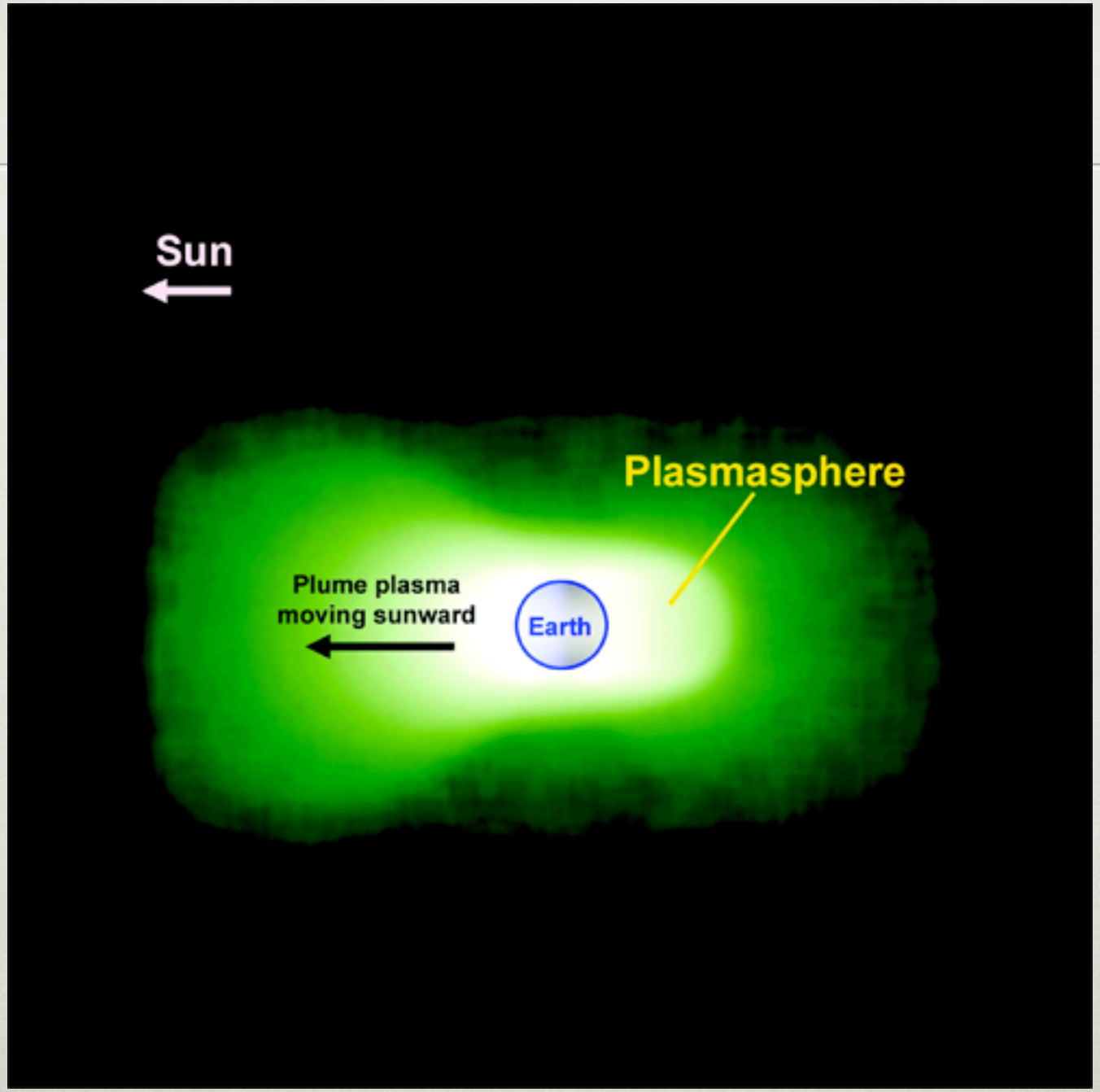
Simulated image of the plasmasphere from Moon



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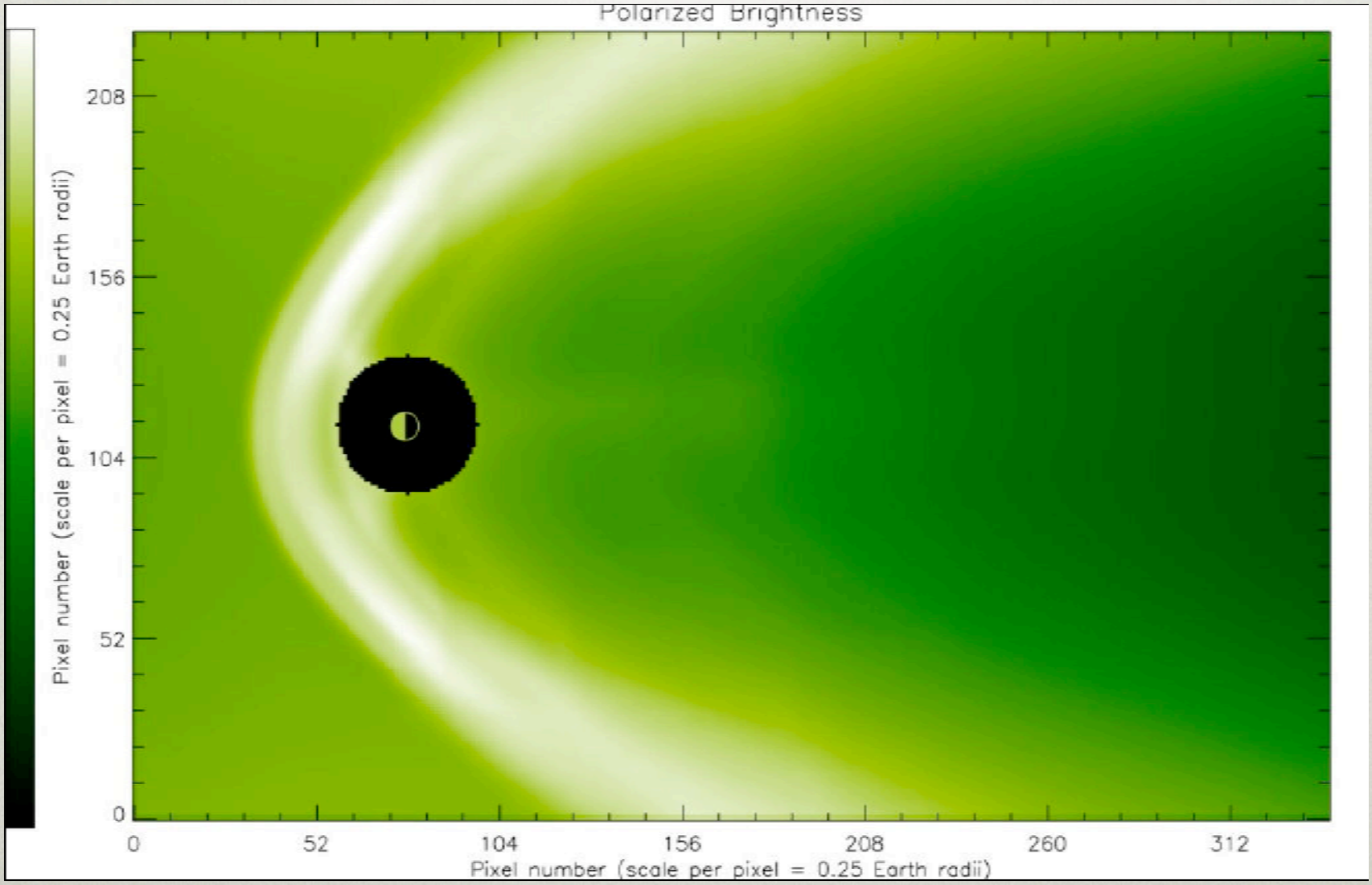
Simulated images of magnetospheri
electron density from Moon



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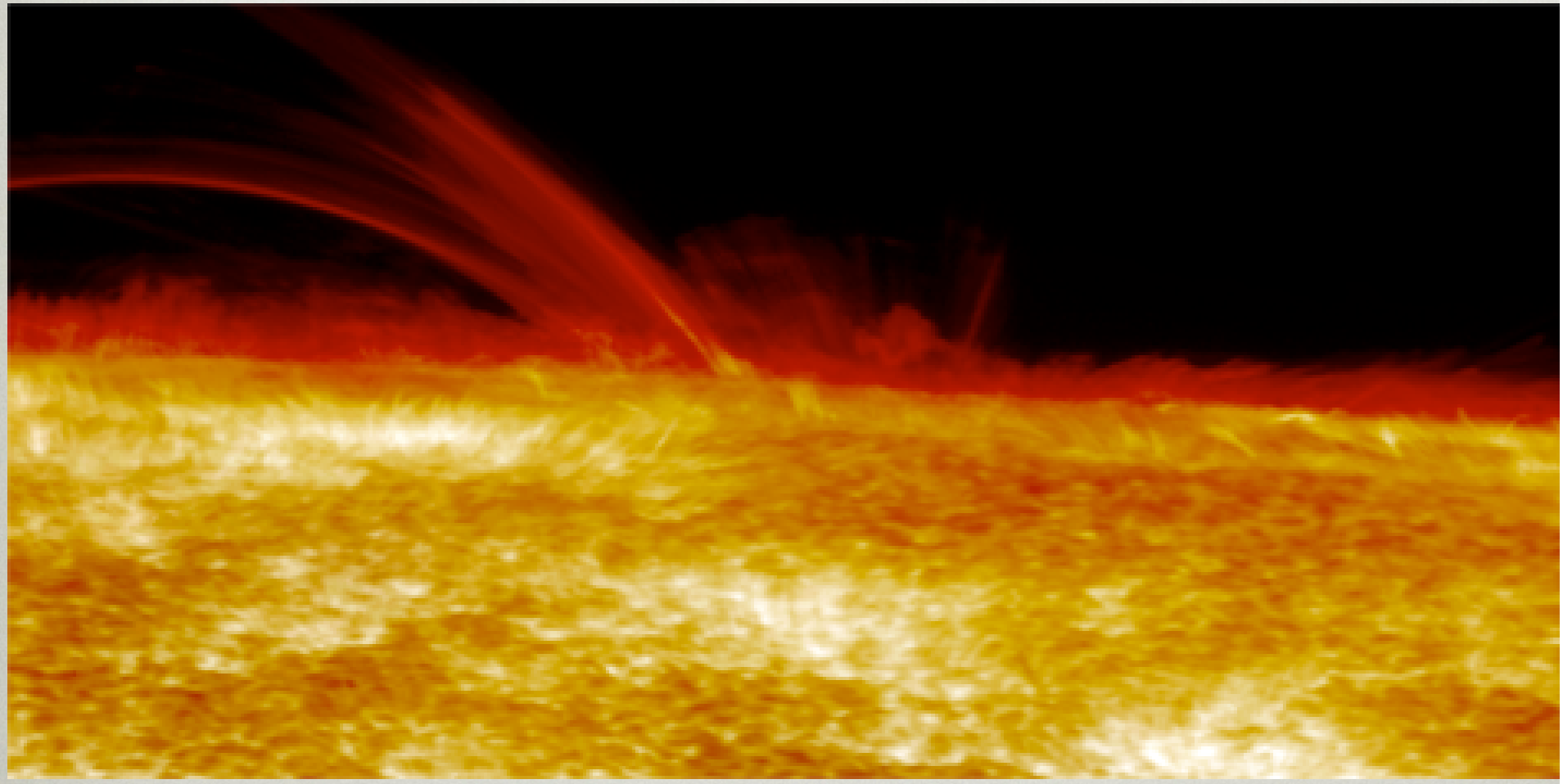
Solar Observatory



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Conclusions

- The lunar surface and lunar orbits provide excellent vantage points for **investigating the lunar environment**, particularly crustal magnetization and dust-plasma interactions

Conclusions

- Lunar-based instrumentation would allow measurements of plasma transport in the magnetotail and would provide important **space weather** monitoring capabilities in support of exploration missions

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Conclusions

- Excavation of the lunar regolith could provide unique and unprecedented data on the particle and irradiance **history of the Sun**

Conclusions

- The lunar surface and lunar orbits offer excellent **vantage points for imaging** of the Sun, Earth and planetary magnetospheres and ionospheres, and the outer boundaries of the heliosphere


The realm of **heliophysics** is the perilous
ocean through which explorers, both
robotic and human, must journey to
reach the dusty shores of the Moon, the
Mars.